# Revisiting the Uranium-238 Thermal Neutron Capture Cross Section

A. Trkov[1], G.L. Molnár[2], Zs. Révay[2], S.F. Mughabghab[3], R.B. Firestone[4], V.G. Pronyaev[1], A.L. Nichols[1]

Cross section databases have to be constantly improved in order to enhance further the predictive power of computational methods for reactor analysis and design. Clearly, the results are highly sensitive to the data adopted for the main uranium isotopes. One of the important recent changes introduced in the ENDF/B-VI library since Release 5 has been an increase of the capture to fission ratio of $^{235}$U in the epithermal energy range. This modification has improved the reactivity prediction in calculations for fast reactors, but caused under-predictions of reactivity in thermal lattices. Obviously, the previously low value for the epithermal capture of $^{235}$U compensated for an error in one or more other parameters, which still need to be identified. The thermal capture cross section of $^{238}$U is an obvious candidate for consideration. Within the Working Party on Evaluation Co-operation (WPEC), Subgroup 22 has been set up to address the problem. The function of the subgroup is primarily to co-ordinate activities and to exchange information, while the actual work is supported by national projects and other sources. Measurements of the thermal capture cross section of $^{238}$U are reviewed in the present work.

Several sets of $^{238}$U thermal capture cross section measurements from the literature were reviewed. Measurements by Hunt *et al* [HU69] and Poenitz *et al* [PO81] are consistent and require no corrections due to updated standards. The measurement by De Corte *et al* [DC88, DC92] is affected by the updated gamma-ray emission probability data; the corrected result is in very good agreement with the previous two studies. A new measurement by Molnár *et al* [MO02, MO03] was also analysed, which uses hydrogen as an internal standard. Although the uncertainty in this measurement is somewhat higher, the resulting data support the other measurements that are considered reliable. Table 1 summarises the results of the re-analysis.

The overall conclusion is that the Mughabghab [Mu84] recommendation for $^{238}$U thermal capture cross section of 2.680 ± 0.019 barns is valid. Old transmission measurements do not rely on neutron activation, and would not affect the average to a large extent because they are in good agreement with the present analysis. However, the recommended thermal cross section value for the ENDF/B-VI library was affected by the Bigham *et al* measurement [Bi69], which is too high. The measurement should be discarded and evaluated nuclear data files containing cross sections for $^{238}$U at thermal energies should be modified accordingly.

Table 1: Summary of thermal capture cross sections of $^{238}$U after re-analysis.

| Author | $s_\gamma$ [b] | $\delta\sigma_\gamma$ [b] |
|---|---|---|
| Hunt *et al* [HU69] | 2.69 | 0.03 |
| Poenitz *et al* [PO81] | 2.680 | 0.019 |
| De Corte *et al* [DC88,DC92] | 2.662 | 0.029 |
| Molnár *et al* [MO02,MO03] | 2.690 | 0.041 |
| Adopted value | 2.679 | 0.019 |

*Footnotes and References*

[1] Nuclear Data Section, IAEA

[2] Institute of Isotope and Surface Chemistry, Budapest

[3] NNDC, Brookhaven National Laboratory

[4] Lawrence Berkeley National Laboratory

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